Flood Control Measures and Related Problems

The Indian government has taken various steps to check or minimise the damage caused by floods.

Storage reservoirs have been built as part of multi-purpose projects over several flood-prone rivers. Some of these reservoirs are Konar, Panchet, Maithan and Tilaiya on Damodar river, Hirakud on Mahanadi, Bhakra on Satluj, Pong on Beas, Ukai on Tapti, Nagarjuna Sagar on Krishna.

Embankments and drainage channels have been constructed to protect towns and land in flood-prone areas.

Certain long-term measures include collection of hydrological data and installation of flood warning systems. These measures, however, have their share of drawbacks and do not, in themselves, provide a comprehensive solution to the menace of flood.

Mere construction of storage reservoirs is not enough. Extensive soil conservation measures, upstream of the reservoir and around it, are required to prevent silting of reservoirs through soil erosion. Silting reduces water holding capacity of reservoirs, thus reducing their efficiency in absorbing the overflow of flood water. According to a study, the rate of sedimentation of reservoirs in India is three times the estimated rate (i.e., estimated when they were built). This has reduced the life of reservoirs in India to one-third. Also, in case the floods are caused by heavy rains in the downstream areas, the reservoirs are not effective. For instance, in Punjab in recent years, the Bhakra and Pong reservoirs have hardly been filled to capacity, while torrential rains caused floods downstreams, affecting nearly half the state's population.

Embankments are not a scientific solution. Embankments are an unnatural way to check the flow of water. Often, the river level is above the surrounding surface in case of an embanked stream, because silt gets accumulated in the riverbed, instead of spilling over onto the flood plain. The flood plain, as a result, is deprived of fertile silt, year after year. Also, in case a breach occurs in a part of the embankment, the water will gush out at a very high speed and cause more damage than a slowly rising unembanked river in flood. The siltation results in floods even if there is moderate rainfall in the catchment areas. The protection provided by embankments is unstable.

Flood-Plain Zoning is a reliable and scientific method. Compared to reservoirs and embankments, this is a 'non-structural' measure. This method is based on the principle that, "where the river has the right of way, stay out of its way". Flood plain is the boundary or extent of the river movement about its mean course. Topographically, it is lower than the surrounding areas and is more prone to flooding.

Flood-plain zoning means demarcating such zones and preventing indiscriminate development and human settlement in such areas. In 1957, the Central Flood Control Board had mooted the idea of demarcating flood zones and the measures to prevent indiscriminate development and settlement in such areas. In 1975, the central government circulated a model bill containing such provisions. It also provided for setting up of flood zoning authorities in all the states to take up surveys and demarcation of flood zones or plains. It recommended legislative support to prohibit the use of flood plains and removal of unauthorised constructions. But most states are yet to take the desired steps under pressure from influential builders, developers and other vested interests. States, on the other hand, ask for huge funds for relief measures and not much is done for long-term protection of the flood-prone areas.

Soils

There can be more than one classification of Indian soils following different criteria. Here we take into account the geographical extent, physical appearance, chemical properties, significance for the purpose of agriculture and the nutritional deficiencies, if any. Broadly, Indian soils can be studied under nine groups.

1. Alluvial Soils

These soils cover 15 lakh square kilometres from the Satluj plains in the west to the lower Ganga-Brahmaputra valley in the east and along east and west coasts in the coastal plains. In the north Indian plains, alluvial soils are derived from debris brought by rivers from the Himalayas and the silt left behind by old sea. The coastal alluvium is of tidal origin. The desert alluvium or **loess** is brought by wind erosion. These soils have a mature profile in flat lands and an immature profile in an undulating surface.

These are the best agricultural soils, because (i) they contain a variety of salts derived from

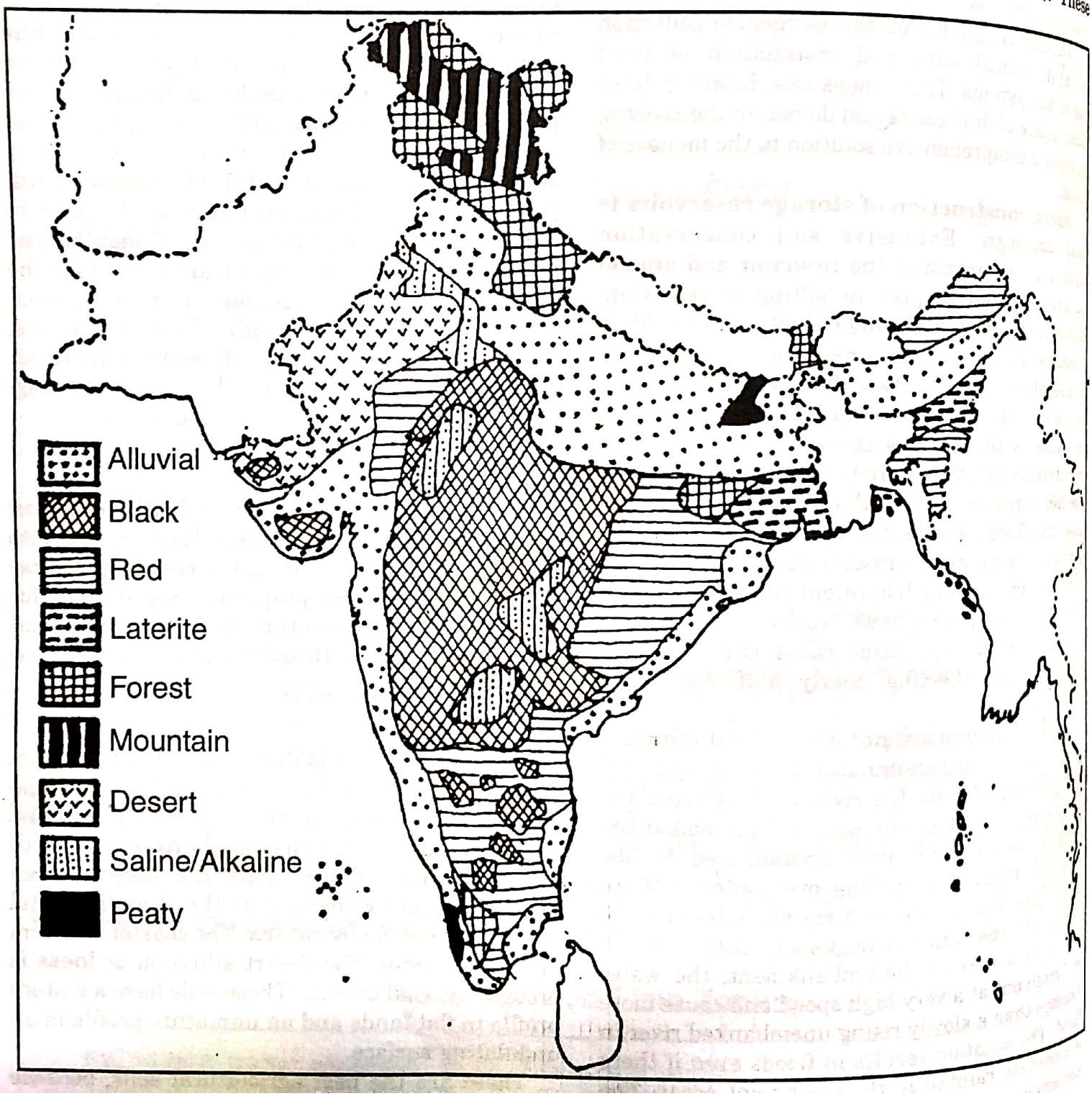
Himalayan rocks; (ii) they are light and porous, therefore easily tillable; and (iii) they are good for canal irrigation because of a high water table and an easily penetrable stratum.

But, because the water is allowed to go very deep, these soils are not suitable for crops requiring water retention around the roots. These soils are rich in potash and poor in nitrogen and organic matter.

2. Black or Regur Soils

These soils cover five lakh square kilometres in Maharashtra, parts of Karnataka, Tamil Nadu, Telangana, Andhra Pradesh, Madhya Pradesh and Gujarat. They are also known as **regur** soils and have a characteristically black appearance.

These soils are derived from two types of rocks—basaltic Deccan and Rajmahal traps and the ferrogenous gneisses and schists in Tamil Nadu, Telangana and Andhra Pradesh. These soils are very clayey (upto 50 per cent clay content) and, therefore, are highly retentive of water. This makes them suitable for dryland farming. Because of a high clay content, these soils expand when wet and become difficult to plough. During the dry season, the black soils shrink and develop big cracks (sometimes upto one metre wide). These



soils vary from calcerous neutral to mild alkaline in reaction, and are deep and rich, fertile in the lowlands but of poor fertility in the uplands.

Black soils are good for cotton and sugarcane cultivation. The black soil regions of Maharashtra and Gujarat have contributed tremendously to the growth of cotton textile industry in the Mumbai-Ahmedabad belt. Black soils are rich in iron, carbonates of magnesium, calcium, and in alumina; they are poor in nitrogen, phosphorus, potassium, and organic matter.

3. Red Soils

These are extensively found covering Tamil Nadu, southern Maharashtra, Telangana, Andhra Pradesh, Karnataka, eastern Madhya Pradesh, Jharkhand, western Odisha and in the sedimentaries of north-eastern mountains. Red soils are derived from weathering of old crystalline and metamorphic rocks under dry conditions, and are red due to the presence of iron oxides. These soils are loamy or sandy and have a low cation exchange capacity and a low base status. These soils are characterised by low water retention capacity.

Red soils are deep and fertile in the lowlands and poor and thin in the uplands. In the lowlands, red soils are found along with black soils and give good crops on irrigation. Red soils are poor in nitrogen, phosphorus, potassium and organic matter.

4. Laterite Soils

These soils cover parts of Western Ghats in Kerala, coastal Odisha, coastal areas of West Bengal and Eastern Ghats and areas of high rainfall in North-East and Bihar.

These are typical soils of the tropics and are the end product of decomposition when high rainfall leaches away calcium and silica leaving behind iron with silica. The iron content gives these soils a red colour. These soils are agriculturally unimportant because of intensive leaching, a low base exchange capacity and their acidic nature. Lateritic soils are poor in nitrogen, phosphorus, potassium, calcium and organic matter.

5. Forest Soils

These soils cover areas between 3,000 m and 3,100 m height in the coniferous region. These are dark soils, rich in decomposed organic matter, but low in pH.

6. Mountain Soils

These soils are spread over altitudes between 2,000 m and 3,000 m. These soils are shallow, silty-loam to loam, well-drained, stony, poorly endowed in organic matter and moderately acidic. The carbon-nitrogen ratio is wide. These soils are subject to dislodgement due to landslides and snowfall. Mountain soils are used for forestry and growing potatoes and subtropical fruits.

7. Desert Soils

These soils cover 1.4 lakh square kilometres. The Thar desert alone accounts for 1 lakh square kilometres and the rest is spread over southern Punjab, Rajasthan and Haryana, where the annual rainfall is less than 50 centimetres.

These soils are covered with a thick brown mantle which inhibits soil growth. Desert soils are derived from adjoining rocks and the coastal region. They are sandy, coarse and alkaline, rich in soluble salts (phosphates and nitrates, though actual nitrate content is low). Therefore, these are actually fertile soils, water being the only limiting factor for agricultural purposes. Poor in organic matter, they have a varying percentage of lime. Desert soils can be reclaimed through good irrigation.

8. Saline And Alkaline Soils

These soils cover arid and semi-arid regions of the northern plains and almost the whole of Maharashtra. The salts from the Himalayas or those derived from the weathering of Deccan rocks get mixed with underground water and during the dry period, come up to the surface through capillary action. The salts, when on the surface, form an efflorescence. These are salts of calcium, magnesium and sodium.

These soils are associated with the subsoil impervious layer or pan, a high water table, canal irrigation (which has the effect of saturating the adjoining water table, especially if under seepage—thus helping the salts to come up to the surface) and an inadequate surface drainage. Local names of saline and alkaline soils include *reh*, *usar, kallar, rakar* and *chopan*. The presence of salt, a cemented layer and bad water retention make these soils unsuitable for agriculture.

9. Peaty Soil

These soils cover the high rainfall areas of West Bengal, Odisha and Kerala. These soils are heavy,

dark and acidic and are formed under conditions of submergence. Peaty soil areas remain submerged during the monsoon and experience accumulation of organic matter with large quantities of soluble salts, such as ferrous and aluminium sulphates which can be, at times, toxic for plants.

Thus, dryness and deficiency of nitrogen and organic matter are the features which are common to almost all the Indian soils.

Vegetation

To study the present state and economic importance of the natural vegetation of India, it is necessary to note the distinction between flora, vegetation and forest. **Flora** refers to plants of a particular region or period, listed as species and considered as a group. **Vegetation**, on the other hand, refers to the assemblage of plant species living in association with each other in a given environmental frame or ecological frame. Finally, the word **forest** is used, often loosely, by administrators and the general public to denote a large tract covered by trees and shrubs.

Most of our Himalayan and peninsular areas are covered with indigenous or *endemic flora*, while the Indo-Gangetic Plain and the Thar Desert contain plant species that generally come from outside, or are *exotic*. Nearly 40 per cent of the plant species found in India are exotic. These exotic plants have come from various locations around the world. Those known as *boreal* have come from the Sino-Tibetan area. The *palaeo-tropical* have come from the neighbouring tropical regions. The arid and semi-arid vegetation cover of the Thar Desert and the western margins of the Gangetic Plains have been influenced by the plant species from north African regions. Those plant species coming from Indo-Malaysia have influenced the vegetal cover of the hilly regions of north-east India.

Much of the plant cover is in a degraded state—i.e., low in quality and content. The **natural vegetation** refers to a plant community that has been left undisturbed over a long time, so as to allow its individual species to adjust themselves to climatic and soil conditions, as fully as possible.

While studying the vegetation types, the focus is on the dominant species, their appearance, adaptation, form, mutual association and stages of growth to reach a climatic climax.

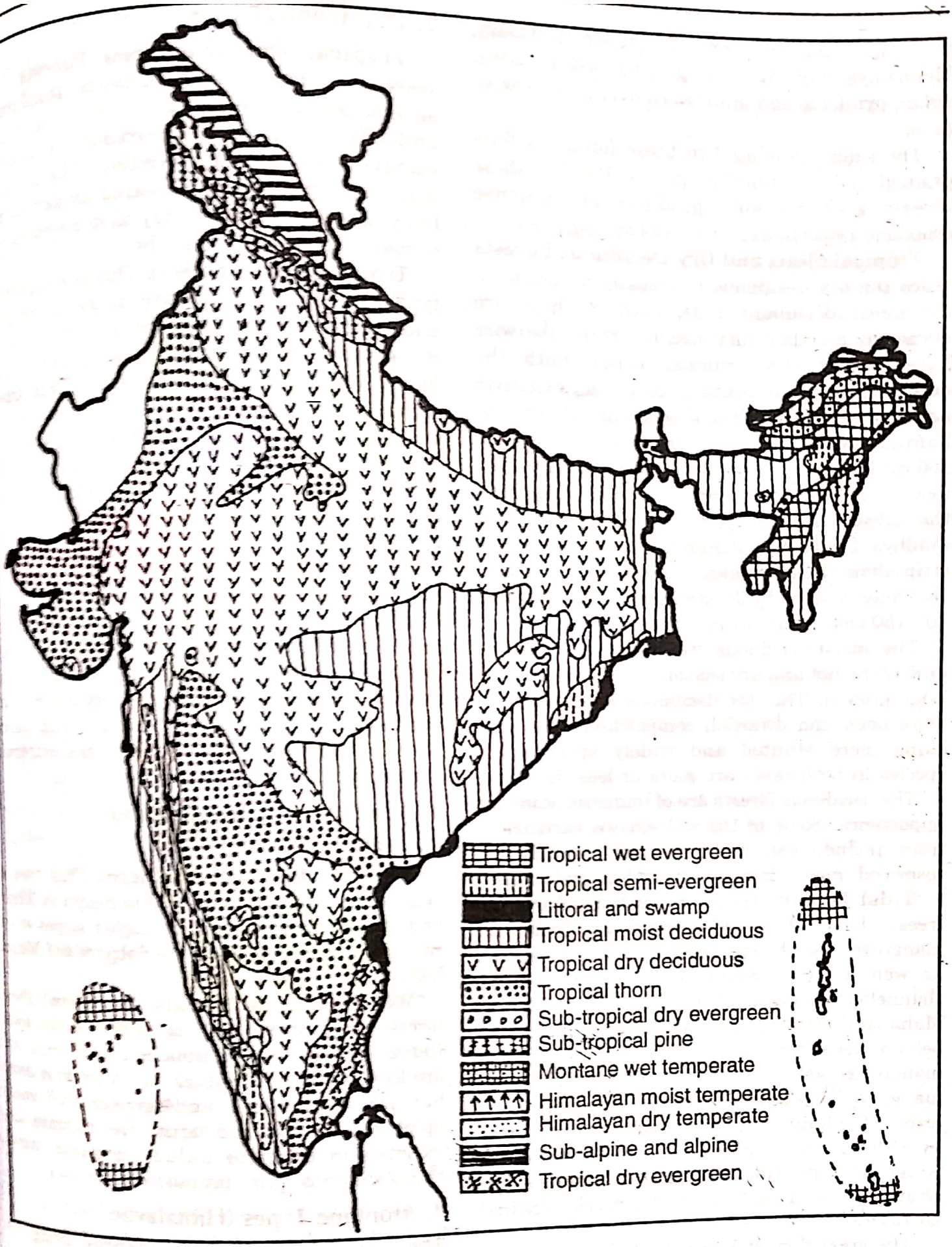
The following classification of natural vegetation in India, which divides the Indian vegetation into five types and fifteen sub-types, is based on studies by H.G. Champion, Schweinfurth, Carl Troll and G.S. Puri.

1. **Moist Tropical Types**
   (a) Tropical West Evergreen
   (b) Tropical Moist Semi-Evergreen
   (c) Tropical Moist Deciduous
   (d) Tidal
2. **Dry Tropical Types**
   (a) Tropical Dry Deciduous
   (b) Tropical Dry Evergreen
   (c) Tropical Thorn
3. **Montane Sub-Tropical and Temperate Types**
   (a) Wet-Hill Forests (Southern)
   (b) Wet-Temperate Forests (Southern)
4. **Montane Types (Himalayan)**
   (a) Wet-Hill
   (b) Sub-Tropical Pine
   (c) Sub-Tropical Dry Evergreen
   (d) Moist Temperate
   (e) Dry Temperate
5. **Alpine Types**
   (a) Alpine

1. Moist Tropical Types

Tropical Wet and Moist Semi-Evergreen Forests These forests occur in areas having more than 250 cm of rainfall annually. The best evergreen forests are found in areas with over 300 cm of annual rainfall and a short dry season. This belt is bounded by semi-evergreen forests on the drier margins, which in turn merges with the tropical moist deciduous forests. The general spatial distribution of tropical wet and semi-evergreen forests covers a strip along the Sahyadris (upto a height of 1,370 m) and large areas in north-eastern India (upto a height of 1,070 m) and Andaman and Nicobar Islands.

These are very dense forests with little undergrowth. Trees reach 45 m in height. There may be associated patches of canes, palms, bamboos, ferns and lianas which are found along breaks in the vegetation, for instance, along stream banks. These forests have a very rich diversity of vegetation—the Sahyadris with evergreen species, and in Assam, the semi-evergreen diversity is very much pronounced. Some important species in these forests include rosewood, aini and telsur in the


Tropical wet evergreen
Tropical semi-evergreen
Littoral and swamp
Tropical moist deciduous
Tropical dry deciduous
Tropical thorn
Sub-tropical dry evergreen
Sub-tropical pine
Montane wet temperate
Himalayan moist temperate
Himalayan dry temperate
Sub-alpine and alpine
Tropical dry evergreen

Sahyadris; champa, toon, and gurjan in Assam, Meghalaya and West Bengal; ironwood, ebony, simar, pyinkado and laurelwood over an extensive area.

The timber produced in these forests is fine-grained and of a durable quality. Besides, these forests give valuable products of immense economic importance, like bamboo, cane, etc.

Tropical Moist and Dry Deciduous Forests Since the dry deciduous is actually a variant of the moist deciduous type, both of these are discussed together (dry deciduous is otherwise listed under Dry Tropical Type). Both the deciduous forests together cover an extensive area bounded by the Himalayas, Thar Desert and Sahyadris—having a moderate rainfall between 100 cm and 200 cm annually. Within this area, the moist deciduous forests are found in a strip along the Sahyadris, covering most of Odisha, eastern Madhya Pradesh, Chhotanagpur Plateau and a strip along the Shivaliks. The remaining area in this zone, covered by dry deciduous types, receives 100-150 cm of rainfall in a year.

The moist-deciduous trees shed their leaves during the hot and dry season. They have a dense undergrowth. The dry deciduous forests have a more open and dwarfish composition—the trees being more stunted and widely spaced. The species in both cases are more or less the same.

The deciduous forests are of immense economic importance. Some of the well-known varieties of trees include sal, teak shisham, sandalwood, rosewood, hurra, myrobalan, mahua and khair.

Tidal Forests These are specialised tropical trees. The tidal coasts of India are lined with mangrove vegetation—which grows in brackish as well as fresh water. The seaward fringes, channels and islands of the deltas of the Ganga, Mahanadi, Godavari and Krishna are lined with belts of dense tidal forests. Along the west coast, mangroves are found along river creeks. The mangrove vegetation tolerates relatively high levels of salinity. The tree trunks are supported by stilt-like roots which get submerged under water at high tide. Mangroves stabilise the shoreline and act as a bulwark against encroachment by sea.

The great Sundarbans delta is covered by the sundari tree. Other species include screw pines, canes and palms.

2. Dry Tropical Types

Tropical Dry Evergreen Forests This vegetation type is confined to coastal Tamil Nadu, an area which receives about 100 cm of rainfall annually (mainly from retreating monsoons between October and December). Large areas with this type have been cleared for agriculture, but wherever they exist, they have closed but low canopy of grasses and shrubs.

Tropical Thorn Forests This is a vegetation type which covers extensive areas in northern and north-western part of the country and along the leeward side of the Sahyadris. An open stunted forest, which gradually degenerates into desert shrubs and grasses westwards, characterises this vegetation type. Biotic changes are mainly responsible for the development of tropical thorn forest. Excessive grazing of savanna and dry deciduous forests have often resulted in tropical thorn forest.

This vegetation type covers a wide variety of species on account of edaphic (soil-related) factors. The tree varieties common to this type include acacia of different types, neem, shisham, khair, pipal, ber, babool, bamboo and khardhai. The western margins of this type of vegetation in the north-west of the country merge with sandy wastes of the Thar Desert which has extremely sparse and thin vegetation cover.

3. Montane Sub-Tropical and Temperate Types

Wet Hill Forests (Southern) This type of vegetation is found upto 1,500 m height in Nilgiri and Palni hills in the south, higher slopes of the Sahyadris and summits of the Satpura and Maikal hills.

Wet Temperate Forests (Southern) These forests occur above 1,500 m height on the south Indian hills of Nilgiri, Annamalai and Palni and are locally known as *sholas*. Shola forest is dense but low with much undergrowth and many epiphytes, mosses and ferns. The common tree varieties in this type include mognolia, laurel, rhododendrons, elm, prunus, etc.

4. Montane Types (Himalayan)

The vegetation undergoes changes along the Himalayas depending on altitude, latitude and aspect. As a result, the vegetation types are different on the lower and higher slopes, as well

as in the western and the eastern sections of the Himalayas.

Wet Hill Forests This type of vegetation is found in eastern Himalayas between 1,000 m and 2,000 m height. Climbers and epiphytes may occur along with evergreen oak, chestnut, ash and peach.

Sub-Tropical Pine Forests This type of vegetation occurs a little west of the wet hill forests at similar altitudes, between 73°E and 88°E longitude, and in some areas in the north-east (Khasi hills in Purvanchal). Chir is a common tree variety of this vegetation type.

Sub-Tropical Dry Evergreen Forests This type of vegetation occurs in a narrow belt in the Himalayan foothills, receiving 50-100 cm of rainfall annually. This forest is more like the Mediterranean shrub Wild olives, *Acacia modesta* and *pistacia* are the important tree varieties.

Moist Temperate Forests This vegetation type covers extensive areas in the entire Himalayan belt at altitudes between 1,500 m and 3,000 m, receiving between 100 cm and 250 cm of rainfall annually. In the east Himalayan zone, this vegetation is in the form of broad-leaved evergreens. Important tree varieties include pine, cedar, silver fir, spruce, deodar with some undergrowth of oak, rhododendrons, laurel and some bamboo.

Dry Temperate Forests This vegetation type occurs in inner Himalayan ranges where the rainfall is below 100 cm. It is an open and xerophytic forest with deodar, juniper and chilgozah. On limestones and steep slopes occurs cypress and in riverine areas is found alder.

5. Alpine Forests

Alpine forests are found in the Himalayan ranges between 3,000 m and 3,500 m altitude as a dense shrubby forest. The Alpine forest degenerates into a low evergreen scrub on the southern slopes and a dry xerophytic vegetation on the northern slopes of the Himalayas. Important tree varieties include silver fir, juniper, pine, birch and rhododendron.

Land Capability Classification

Landuse capability classification indicates the suitability of various kinds of soil for economic uses, mainly agriculture. The classification devised for Indian conditions draws heavily from the classificatory approach followed by the United States Department of Agriculture. The guiding principles for this classification are the limitations imposed on the sustained use of soils by the basic characteristics of soils in combination with climate, topography, surface drainage, vegetation cover, erodibility and other natural hazards.

There are eight land capability classes which are indicated by Roman numbers I to VIII. Then, there are capability sub-classes and capability units. The classes I to IV include lands suited for cultivation and should be maintained under natural vegetation of forests or grasses.

This scheme of land capability classification is based on economic returns in terms of agricultural output because agriculture is the most widespread and basic occupation in India. The various classes and their characteristic features are as follows.

Class I Soils in this class are very good. The soils are deep, productive and easily worked and nearly level. They are not subject to overflow (run-off) damage. However, they are subject to variations of fertility and puddle erosion. Soils of this class have slight or no risk of damage. These are the most productive parts of our country and are to be found in flood-plain regions of the country.

Class-I soils used for crops need practices to maintain soil fertility and soil structure. These practices involve use of fertilisers, cover cropping, green manure crop and crop rotation.

Class-II As far as natural conditions are concerned, the land is excellent, but some limitation is possible, which may restrict the choice of crops to some extent. Soils of this group can be cultivated with easily applied practices, and a majority of crops can be grown. They are, however, subject to moderate risk of damage. Soils of this group have gentle slopes and are subject to moderate erosion. They are also subject to moderate overflows. These are areas of specialised cropping and are commercially one of the most suitable parts of our land.

These soils may require special practices, such as contour tillage, crop rotation and water-control devices.

Class III These are moderately good soils. They can be used regularly for crops. These soils have steep slopes and suffer from either some ecological problem (as soil erosion) or climatic problem (rainfall irregularity) which inhibits intensive commercial exploitation. Also, these soils are inherently low in fertility.